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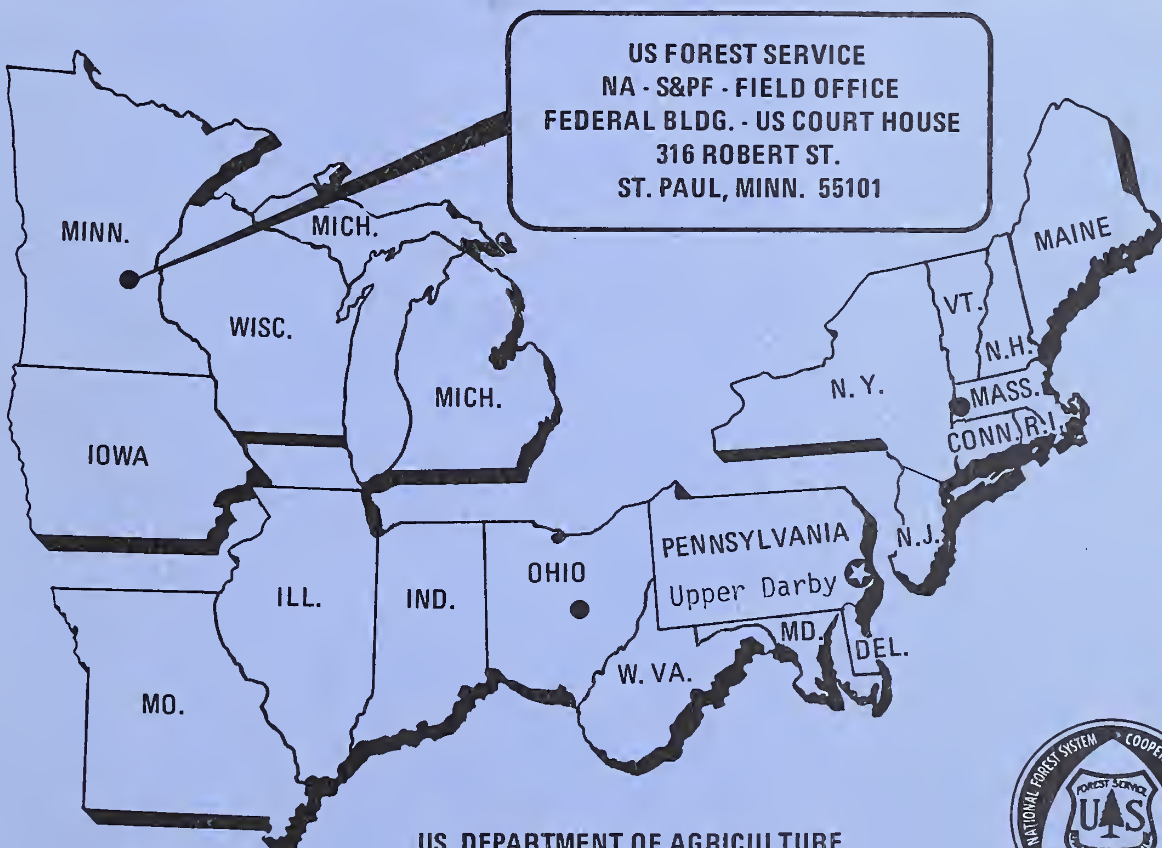
BIOLOGICAL EVALUATION OF THE SPRUCE BUDWORM ON THE SUPERIOR NATIONAL FOREST - 1968

By I. Millers, G.W. Erickson, and A.R. Hastings



US DEPARTMENT OF AGRICULTURE
FOREST SERVICE

BIOLOGICAL EVALUATION OF THE SPRUCE BUDWORM ON THE SUPERIOR NATIONAL FOREST - 1968

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ABSTRACT

Defoliation of fir and spruce by the Spruce budworm, Choristoneura fumiferana (Clem.) covers about 130,000 acres of spruce/fir type on the Superior National Forest. Of this total acreage, about 100,000 acres were classed as severely defoliated in aerial and ground defoliation surveys. An egg-mass survey shows that budworm populations will remain high. Tree mortality is expected unless further defoliation is prevented. Budworm populations can be reduced by either natural control agents or chemical suppression. The Superior National Forest should complete the evaluation of budworm damage and also consider conversion from fir to non-host tree species in recreational areas.

INTRODUCTION

The spruce budworm, Choristoneura fumiferana (Clem.) is one of the most devastating insect pests of spruce-fir forests in North America. Blais (1968) reviews spruce budworm outbreak history during the last 250 years. The earliest record in Minnesota is the 1911 outbreak, when more than 20 million estimated cords of balsam fir were killed (Graham and Orr, 1940). The next budworm outbreak occurred from 1954 to 1963, when more than 1.5 million cords of pulpwood were killed (Weber, 1964). The budworm population declined rapidly in 1963 (Ryan and Batzer, 1964), and it was considered endemic until 1967.

An upsurge of the spruce budworm was detected in 1967 during the jack-pine budworm aerial survey. After ground examinations, about 40,000 acres of gross area (this includes non-host areas within outbreak boundary) were found defoliated (Map 1). Stands in several locations appeared to be in the second or third year of defoliation.

This report presents the 1968 biological evaluation of the spruce budworm and is based primarily on aerial defoliation and egg-mass surveys.

TECHNICAL INFORMATION

A. Causal Agent

Spruce budworm, Choristoneura fumiferana (Clem)

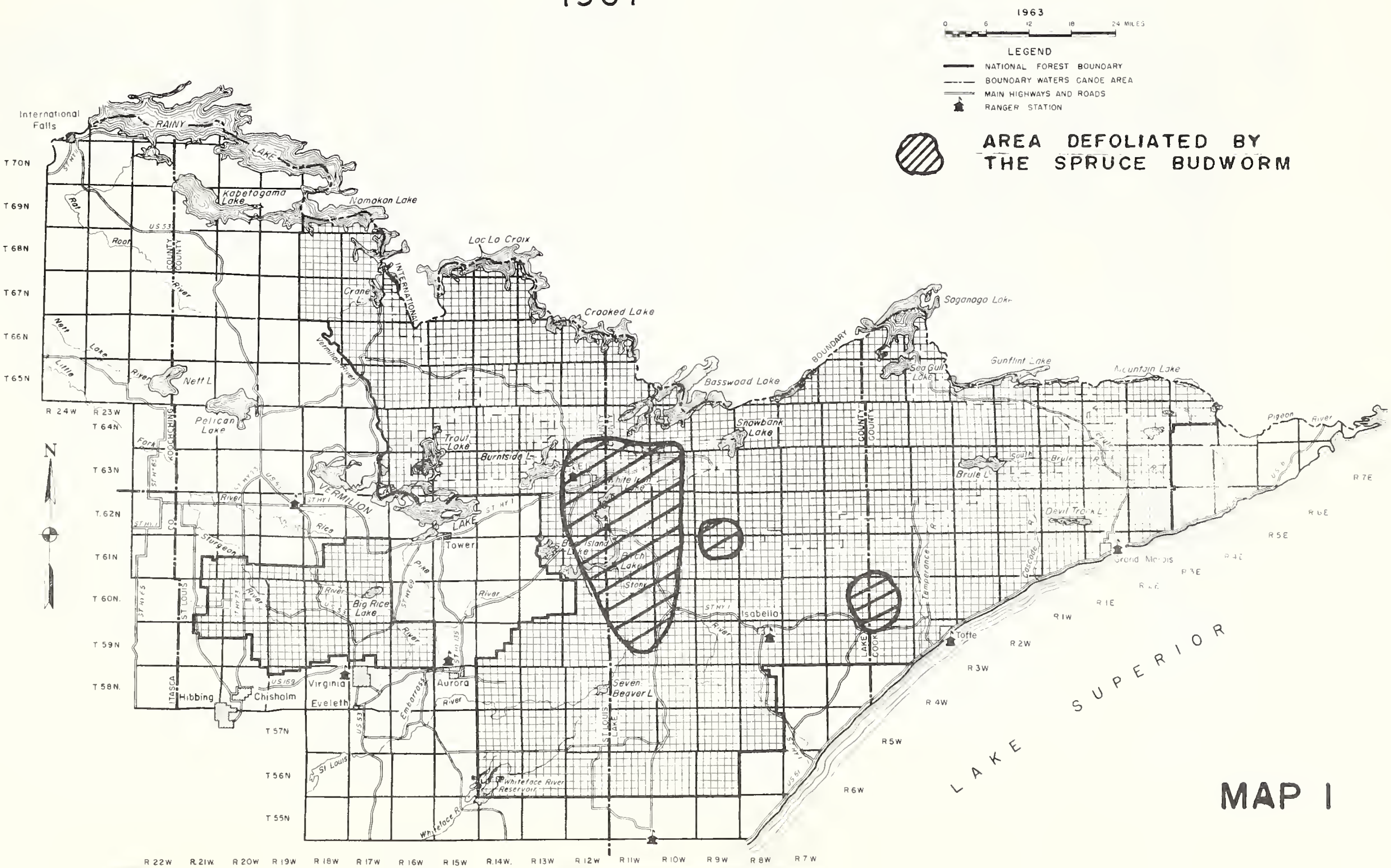
B. Host Trees Attacked

Balsam fir, Abies balsamea (L.) Mill.
White spruce, Picea glauca (Moench.) Voss

SPRUCE BUDWORM DEFOLIATION

SUPERIOR NATIONAL FOREST

1967



MAP I

C. Type of Damage

Damage occurs as a result of larval feeding on needles and mining of buds. Current foliage and buds are damaged first. Older foliage is damaged after the preferred food supply is exhausted. Severe defoliation for 3 or more successive years results in tree mortality (Bean and Waters, 1961).

D. Ecological Considerations

Many parasites, predators and diseases attack the spruce budworm, but their role in outbreak suppression appears to be minor(Bean and Waters, 1961; Morris et al, 1963). Adverse weather is reported as a mortality factor elsewhere (Wellington, 1954). However, on the Superior National Forest the current outbreak has increased during 2 years of apparently unfavorable weather, i.e., cool and wet springs and summers.

The most promising cultural control method appears to be conversion from budworm susceptible fir stands to non-host trees. This may be feasible in small high-value areas such as campgrounds. Forest wide it is impractical, since the ecological succession favors balsam fir.

E. Extent and Location of Outbreak.

The extent of spruce budworm defoliation was determined by an aerial survey(Appendix I-Method). Ground examinations were made to confirm and to measure the level of budworm defoliation. These were made in conjunction with an egg-mass survey (Appendix II-Method). The results are shown in Map 2.

The Superior National Forest has 197,000 acres of spruce-fir type. Of this, 96,000 acres, mostly in the northern half of the Forest, is severely (95-100%) defoliated; 36,000 acres is lightly to moderately (40-94%) defoliated; and, 65,000 acres is none to lightly (0-49%) defoliated. Most of this latter class is in the southern tier of townships and east of Sawbill Trail.

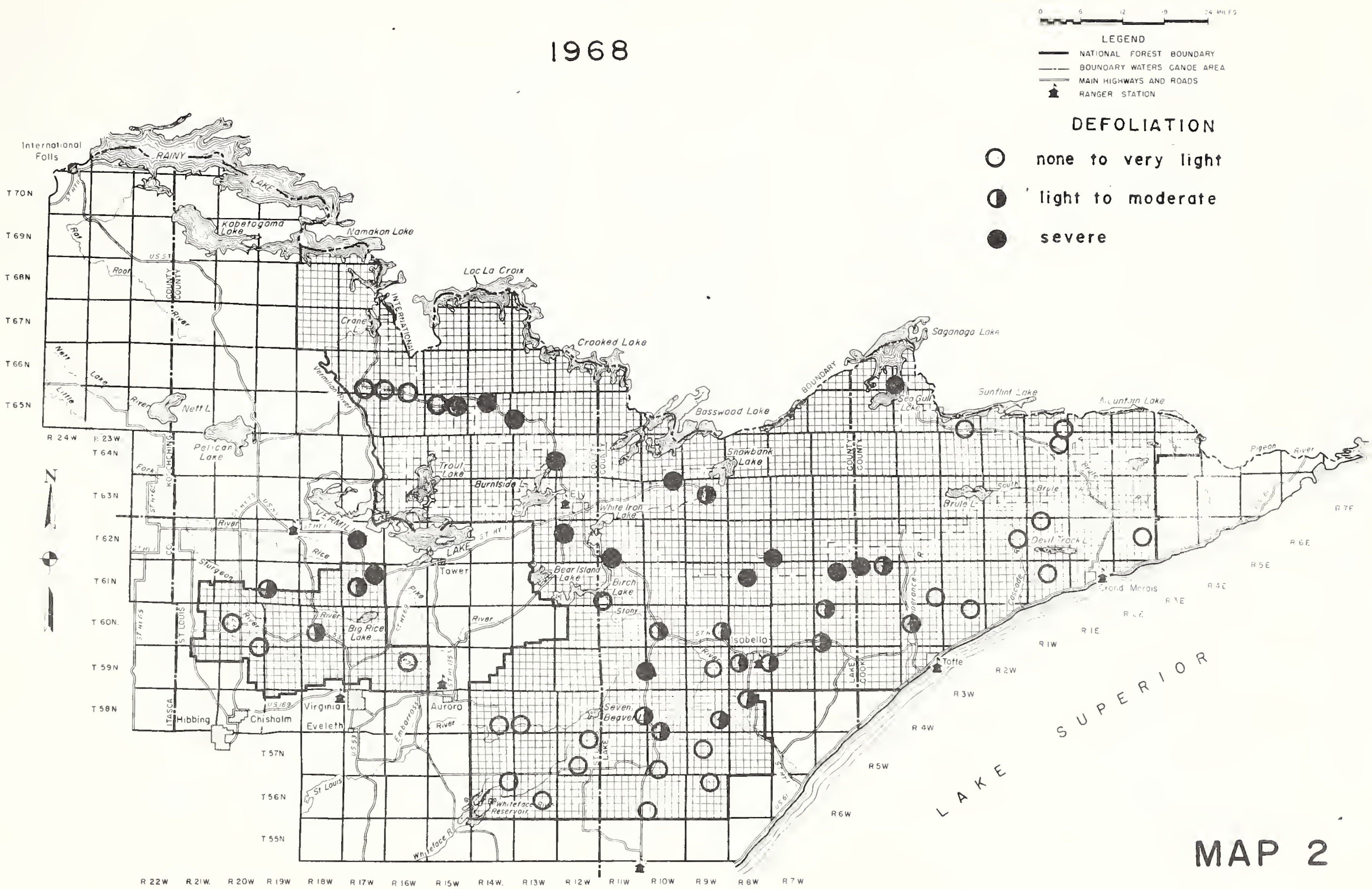
F. Trend of Outbreak.

The probability of various defoliation classes resulting from given egg-mass populations is presented in Table I.

SPRUCE BUDWORM DEFOLIATION

SUPERIOR NATIONAL FOREST

1968



MAP 2

TABLE I PROBABILITY OF DEFOLIATION CLASSES RESULTING FROM GIVEN EGG MASS POPULATIONS (Modified from Bean & Batzer 1961)

Egg Mass Population		Probability of Defoliation		
Egg Mass Population Class	Av. No. Egg-masses per 15" Twig	Defoliation Classes None to Light	Moderate	Severe
None to Light	0-0.1	90%	10%	0
Moderate	0.1-1.7	30%	40%	30%
High	1.8+	0	20%	80%

On the basis of the egg mass data collected (Map 3 and Appendix III) defoliation is expected to continue in the outbreak area and further expansion is likely in 1969.

F. Discussion

The resurgence of spruce budworm was first noticed in 1967 during the aerial defoliation survey for jack-pine budworm (Choristoneura pinus Freeman). Ground examinations at that time suggested that some fir stands had been defoliated in 1966 in the Meander Lake and Windy Lake areas. In these two areas tree mortality is common this year. In 1968 nearly half the spruce-fir type on the Forest is in the first or second year of severe defoliation. Another year of severe defoliation will increase tree mortality.

Since the egg-mass survey indicates that a high larval population is entering hibernation, severe defoliation can be expected in many of the areas in 1969(Map 3). This will seriously affect balsam fir survival, unless larval population reduction is effected. Since natural budworm mortality factors have not been effective, an aerial application of insecticide should be considered if the resource values warrant it.

The staff of the Superior National Forest has expressed concern about the possible loss of balsam fir in some recreation areas and summer home sites. Annual or biennial insecticidal treatments can protect small areas, but will not affect the general outbreak conditions. Reinfestation from untreated surrounding areas should be expected.

DDT was used successfully during the 1962 spruce budworm control project on the Superior N.F. However, adverse side effects limit its

SPRUCE BUDWORM EGG SURVEY

SUPERIOR NATIONAL FOREST

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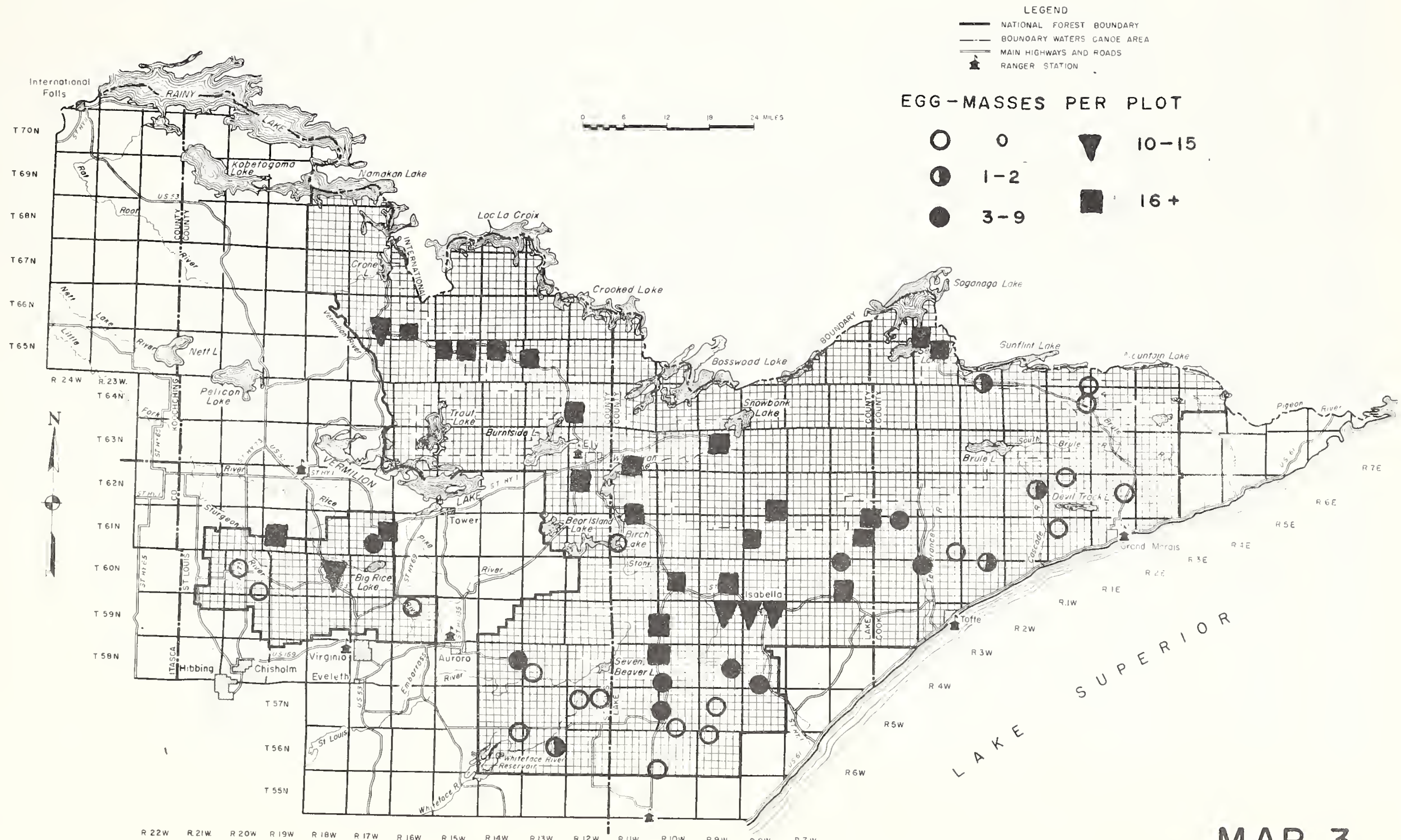

MAP 3

use at present. Several insecticides have been extensively field tested as substitutes for DDT. Malathion, Phosphamidon, Sumithion, and Zectran have shown the most promise.

Two other insecticides, Matacil and Dylox, have shown promise in limited testing, but too little is known about their effectiveness and adverse effects to consider their use at this time.

Malathion is the only one to have a U.S.D.A. registration for use against spruce budworm. Tests of its effectiveness have yielded variable results. Because of its short residual effectiveness, precise timing and thorough coverage in application is essential. The adverse effects, i.e. hazards to fish and wildlife and human exposure are minimal at rates recommended for use. Malathion can cause damage to acrylic lacquer type paints exposed to deposits of the concentrated material. This danger can be eliminated by covering such surfaces or washing immediately after application. When Malathion is used for spruce budworm control the recommended rate is 13 fluid ounces per acre of Low Volume Concentrate (LVC). The estimated cost for material at this rate would be about $1.00 per acre ($10.14/gal.)

Sumithion is a new phosphate insecticide. It is not available from a U. S. insecticide manufacturer. A supply may be available from Cyanamid of Canada, Ltd. It has no label registration for spruce budworm in the United States. A special label approval would have to be obtained through the Federal Committee on Pest Control before it could be used. Rates of application which have shown promise in Canadian tests are: (1) as a single application of 6 ounces per acre(active ingredient) (2) a double application of 4 ounces per acre, and, (3) one 4 oz. application of Sumithion and 4 oz. of Phosphamidon. At rates above 6 ounces/acre mortality has been reported of forest bird species that are primarily insect feeders. Sumithion is not considered hazardous to humans when used at application rates given above. Based on costs of the material used in the Maine Pilot Study in 1968 the per acre cost for material would be about $0.84/acre($17.97 per gallon for 8 lb. per gallon Sumithion emulsion concentrate).

Phosphamidon, has been tested alone and in combination treatments with Sumithion in Canada. Results show this material to be more toxic to birds than Sumithion but less so to fish. Single application rates in excess of 4 oz. per acre have seriously affected bird populations. Two separate applications of 1/8 lb. per acre each have been used without adverse effects. Cost estimates of this material at 4 ounces per acre are $1.14 per acre based on a price of $36.55 per gallon of material. Phosphamidon is extremely corrosive to spray equipment.

Zectran, a carbamate insecticide, has been tested for control of the spruce budworm in the West with success. A pilot study in Maine, 1967, failed to achieve the required 95% population reduction set as a criteria for successful control. Zectran is non-hazardous at the low rates of application used in the West, (1.5-3 ounces per acre). No cost estimates are available and this material will not be commercially available in 1969.

Further review of research information on new insecticides, their effectiveness, adverse effects and costs will be made before final control recommendations are made.

H. Recommendations

1. The Superior National Forest should complete the evaluation to determine the effects of spruce budworm defoliation on recreation, timber, water and wildlife resources.

2. The Forest can consider conversion from balsam fir to budworm resistant host species in high value areas.

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APPENDIX I
DEFOLIATION SURVEYS
AERIAL & GROUND METHODS

Objective

To determine the area and the relative intensity of spruce budworm defoliation on the Superior National Forest.

Methods - Aerial

Area of Survey: Superior National Forest

Timing: July 1-3, 1968

Aircraft: Forest Service Cessna 180 located at the Ely Service Center, Superior National Forest

Flight Conditions:

a. Height, 1000 feet above ground
b. Air speed, 100-120 miles per hour
c. Flight pattern - Flight lines were flown in a north-south or east-west direction depending on time of day and light conditions. Lines were spaced at 3-6 mile intervals depending on forest type being viewed.

Mapping Technique: Sketch mapping on a $\frac{1}{2}$ inch to a mile map.

Air Crew: Glen Erickson, Technician, and Arthur Clarke, Summer Student, from St. Paul Field Office; Walter Newman, Pilot, Ely Service Center.

Ground-Method

Ground Checking Crew: Glen Erickson, Technician, St. Paul Field Office; Arthur Hastings, Entomologist, St. Paul Field Office; John Kernik, Forester, Superior National Forest; Imants Millers, Entomologist, St. Paul Field Office; Gary Simmons, Summer Student, St. Paul Field Office.

Ground Checking: Cursory examinations were first made in the main spruce-fir areas. Then, a systematic sample was taken at 54 balsam fir plots and 23 white spruce plots in conjunction with the egg-mass survey (Appendix II)

Occular defoliation estimates were made in the general area of the plots and on individual twigs from the plot. Each plot was represented by three twigs cut from the mid-crown of each of 3 dominant and/or co-dominant balsam fir or white spruce (total of 9 twigs).

Defoliation here is defined as reduction of current foliage due to budworm feeding on the buds and needles. First, the defoliation was

estimated for each sample twig and ranked 0-4 (Table I). Then, the numerical average was determined for the plot and given a descriptive class designation (Table I.) Occasionally, the defoliation class was increased when supplemental observation showed that the stand was more defoliated than the sample trees. When 2 plots (1 spruce and 1 fir) were taken, only the more severe defoliation class is shown on the map (Map 2).

No ground checks were made within the Boundary Waters Canoe Area.

TABLE I. CLASSES OF DEFOLIATION BASED ON PERCENT REDUCTION OF CURRENT FOLIAGE ON NINE-15 INCH TWIGS

TWIG DEFOLIATION		PLOT DEFOLIATION	
Percent Range	Rank	Av. Rank Range (9 twigs/plot)	Class
0-4	0	0	None
5-40	1	0.1-1.0	Very light
41-60	2	1.1-2.0	Light
61-94	3	2.1-3.0	Moderate
95-100	4	3.1-4	Severe

APPENDIX II
EGG-MASS SURVEY

Objective

To determine the egg mass levels on the Superior National Forest, with particular emphasis on high value recreation areas.

Methods

A preliminary field evaluation of the problem was made by Messrs. A. R. Hastings and I. Millers, both from the St. Paul Field Office; and J. Kernik, Forester, Superior National Forest. At this time the general objectives of the evaluation and the particular areas of concern were established.

Plots were located along roads at 3-6 mile intervals in spruce-fir type. Where possible paired plots were established--1 for balsam fir and the other for white spruce. A total of 54 balsam fir plots and 23 white spruce plots were established.

Each plot consists of a cluster of 3 trees located as close as possible to each other. The sample trees were chosen from dominant and/or co-dominant trees growing in the open and with green foliage on at least 3/4 of the height. Trees immediately adjacent to frequently traveled roads were avoided.

The survey was made between August 12-23. All the oviposition was completed by this time and the eggs had hatched.

Each tree was sampled at the mid-crown. Three 15 inch twigs (measured from the terminal bud and along the main axis) were cut from each tree and tied in a bundle. The 3 bundles from each plot were placed in one sack. The samples were examined at the Kawishiwi Field Laboratory of the North Central Forest Experiment Station.

Twig samples from each plot were examined until the total of 16 egg-masses were found, or until all 9 twigs were examined. (Defoliation estimates were made for all twigs.) The plot data are shown in Appendix III.

The following assumptions are made:

1. 0-1 egg-mass per plot is a light population

2. 16 or more egg-masses per plot is a high population, averaging more than 1 egg-mass per twig.

3. 2-15 egg-masses per plot may represent a moderate population, but it also may be the result of insufficient number of twigs to make a decision. Therefore, the limits for these populations were set arbitrarily. The small number of twigs per plot were taken to achieve a greater number with limited man-power available and wider distribution of plots.

APPENDIX III

SPRUCE BUDWORM EGG-MASS COUNTS AND PREDICTED 1969 DEFOLIATION BY PLOTS ON THE SUPERIOR NATIONAL FOREST

BALSAM FIR PLOTS

Plot Number	Town-ship	Range	Sec-tion	Total No. Egg-masses	Predicted 1/ Defoliation Class
1	61	11W	4	16+	S
3	59	16W	9	0	NL
4	60	20W	35	0	NL
5	60	20W	17	0	NL
6	61	19W	29	16+	S
7	60	18W	15	10	M
8	61	17W	27	7	M
9	61	17W	23	16+	S
10	62	12W	8	16+	S
11	61	11W	30	1	LM
12	66	4W	31	16+	S
14	65	3W	34	0	NL
16	64	1W	1	0	NL
17	64	1W	12	0	NL
20	62	1W	4	0	NL
22	62	2W	14	0	NL
23	61	1W	9	0	NL
24	60	3W	3	1	LM
25	61	4W	25	0	NL
28	61	5W	3	0	NL
29	61	6W	1	16	S
30	61	6W	14	16+	S
31	60	6W	5	5	M
32	60	6W	29	5	M
34	66	17W	26	8	M
38	65	15W	10	16	S
39	65	14W	9	16+	S
40	65	13W	19	16+	S
41	64	12W	30	16+	S
43	58	13W	19	0	NL

1/ Prediction based on Table I in the main text. The following key is used:

NL - none to light defoliation; 0 total e.m. per plot
LM - light to moderate defoliation; 1-2 total e.m. per plot
M - moderate defoliation; 3-9 total e.m. per plot
MS - moderate to severe defoliation; 10-15 total e.m. per plot
S - severe defoliation; 16+ total e.m. per plot

BALSAM FIR PLOTS, (CONTINUATION)

Plot Number	Town-ship	Range	Sec-tion	Total No. Egg-masses	Predicted Defoliation Class
44	58	14W	23	3	M
45	57	12W	11	0	NL
46	57	12W	8	0	NL
48	56	13W	14	1	LM
49	56	14W	1	0	NL
102	61	8W	19	16+	S
103	62	8W	35	16+	S
105	59	8W	10	11	MS
107	60	9W	22	16+	S
109	59	8W	7	11	MS
111	59	9W	10	11	MS
113	59	11W	24	16+	S
114	60	10W	21	16+	S
116	63	9W	16	16+	S
118	63	11W	33	16+	S
120	58	11W	12	16+	S
121	58	10W	31	3	M
122	57	10W	19	3	M
123	56	10W	31	0	NL
124	57	10W	33	0	NL
125	56	9W	5	0	NL
126	57	9W	16	0	NL
127	58	9W	23	4	M
128	59	8W	33	6	M

WHITE SPRUCE PLOTS

Plot Number	Town-ship	Range	Sec-tion	Total no. Egg-masses	Predicted Defoliation Class
2	61	11W	4	9	M
13	66	4W	31	16+	S
15	65	3W	34	1	LM
18	64	1E	32	0	NL
19	62	2E	14	0	NL
21	62	2W	14	2	LM
26	60	4W	6	7	M
27	61	5W	3	6	M
33	60	6W	29	7	M
35	66	17W	26	10	M
36	66	16W	33	16+	S
37	65	15W	8	16	S
42	64	12W	30	16+	S
47	56	13W	14	0	NL
101	61	8W	19	16+	S
104	62	8W	35	16+	S
106	59	8W	10	1	NL
108	60	9W	22	16+	S
110	59	8W	7	5	M
112	59	11W	24	16+	S
115	60	10W	21	16+	S
117	63	9W	16	16+	S
129	59	8W	33	0	NL